

## Computational model of a modulatory cell type in the feeding network of the snail, *Lymnaea stagnalis*

Article (Unspecified)

Vavoulis, Dimitris V., Nikitin, Eugeny S., Feng, Jianfeng, Benjamin, Paul and Kemenes, György (2007) Computational model of a modulatory cell type in the feeding network of the snail, *Lymnaea stagnalis*. BMC Neuroscience, 8 (Supp 2). p. 113. ISSN 1471-2202

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/1573/>

This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

### **Copyright and reuse:**

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

# The ionic basis of action potentials in an identified modulatory cell type in the feeding network of the snail, *Lymnaea stagnalis*: a computational study

Dimitris V. Vavoulis<sup>1,2</sup>, Eugeny S. Nikitin<sup>2</sup>, Jianfeng Feng<sup>1</sup>, Paul R. Benjamin<sup>2</sup>, György Kemenes<sup>2</sup>

<sup>1</sup>*Ctr. for Scientific Computing, Uni. Of Warwick, Coventry, United Kingdom*

<sup>2</sup>*Sussex Ctr. for Neuroscience, Uni. of Sussex, Brighton, United Kingdom*

email: [Dimitris.Vavoulis@dcs.warwick.ac.uk](mailto:Dimitris.Vavoulis@dcs.warwick.ac.uk)

## Introduction

Realistic mathematical models of single neurons are significant in assessing the contribution of specific ionic conductances to neuronal excitability. This study presents a detailed computational model of the Cerebral Giant Cells (CGCs), a pair of serotonergic neurons in the feeding network of *Lymnaea stagnalis*, which are critical for the expression of motor behaviour (feeding) and the formation of long-term memory.

## Methods

First, we fitted a single-compartment, Hodgkin-Huxley model of the CGCs to two-electrode voltage- and current-clamp data [1] using a combination of linear and non-linear least-square fitting techniques. Then, we selectively blocked each ionic current to assess its role in the model, thus mimicking the application of pharmacological agents in the biological neuron.

## Results

The model replicates accurately the shape of the action potentials and the tonic firing ( $\sim 0.74$  Hz) of the biological neuron (Fig. 1A). A persistent sodium current  $I_{NaP}$  and a transient low-threshold calcium current  $I_{LVA}$  keep the neuron spontaneously active (Fig. 1Bi,ii). A transient potassium current  $I_A$  regulates the interspike interval, while a transient high-threshold calcium current  $I_{HVA}$  increases the duration of each spike (Fig. 1Biii,iv). Transient sodium and delayed rectifier potassium currents are responsible for the depolarizing and repolarizing phases of the action potential, as in the classical Hodgkin-Huxley model. The available experimental data [1] are in agreement with these conclusions.

## Conclusions

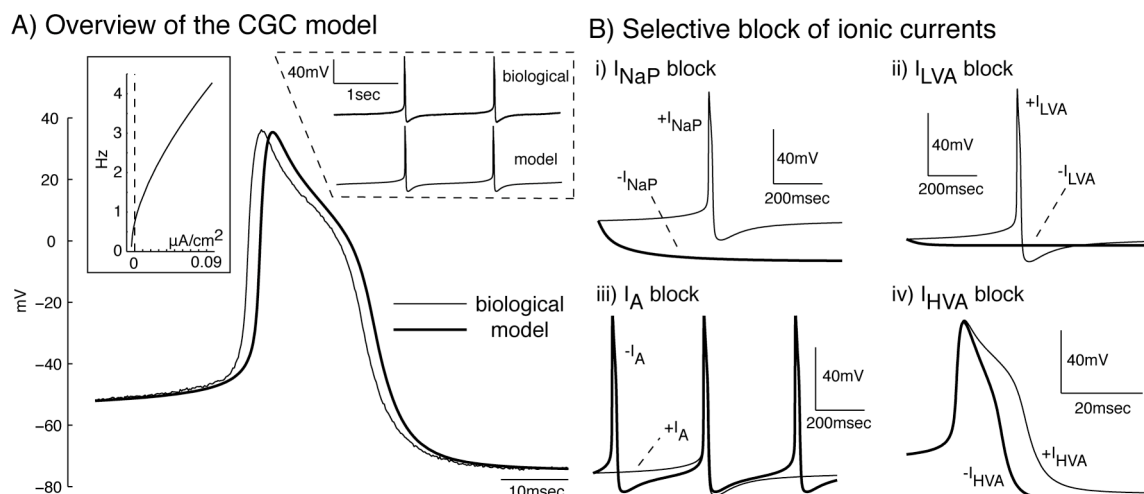
The model we have developed here provides an accurate description of the CGCs at the biophysical level and it is a useful tool for studying the electrical properties of these important modulatory neurons.

## Acknowledgments

This research was supported by EPSRC and BBSRC, United Kingdom

## References

1. K. Staras, J. Gyori & G. Kemenes: **Voltage-gated ionic currents in an identified modulatory cell type controlling molluscan feeding.** *Eur J Neurosci* 2002, **15**: 109-119



**Fig. 1:** Overview of the CGCs model and the contribution of specific currents to neuronal excitability. In A, the model has been slightly (2msec) shifted to the right for illustration purposes